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(71) Applicant *(for all designated States except US)*: RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY [US/US]; ASB, Annex 11, 58 Bevier Road, Piscataway, NJ 08854–8010 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: YAM, Kit, L. [US/US]; 40 Linden Lane, Plainsboro, NJ 08536 (US). SABA, Raymond, G. [US/US]; 4 Hardley Drive, Cranberry, NJ 08512 (US). LACHANCE, Paul, A. [US/US]; 34 Taylor Road, RD4, Princeton, NJ 08540–9521 (US). DELPRAT, Julien [FR/US]; ASB, Annex 11, 58 Bevier Road, Piscataway, NJ 08854–8010 (US).

(74) Agents: LICATA, Jane, Massey et al.; Law Offices of Jane Massey Licata, 66 E. Main Street, Marlton, NJ 08053 (US).

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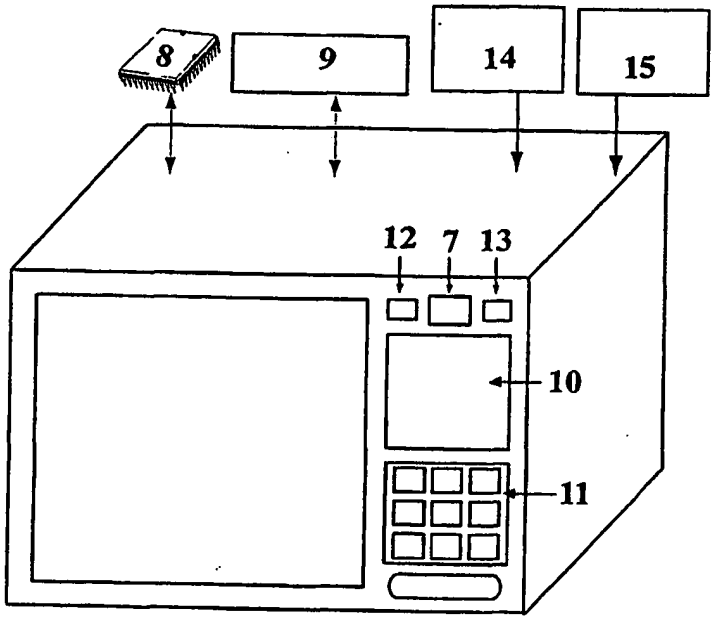
(54) Title: INTELLIGENT MULTI–MODAL FOOD PREPARATION APPLIANCE

(57) Abstract

A multi–modal food preparation appliance is provided which includes a heating system (15) with multiple heating devices and fan; a microprocessor (6) linked to the heating system (15) which controls independently operation of the multiple heating devices and fan of the heating system, wherein the microprocessor (8) has the ability to access internal and external databases with information for operation of the heating system; a scanner (7) linked to the microprocessor (8) wherein scanning of a code or symbol initiates the microprocessor to access internal and external databases for information to operate the heating system; and an internal database storage (9) linked to the microprocessor for storage of information.



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INTELLIGENT MULTI-MODAL FOOD PREPARATION APPLIANCE

Background of the Invention

Cooking appliances presently in use, such as microwave/conventional ovens, primarily employ electrical or mechanical keyboards as the data entry mechanism. Typically, the consumer must first find, read, and understand food preparation instructions on the package before being able to input the correct data to the oven. However, the manufacturer's instructions are necessarily general and vague, since the manufacturer does not know the operating characteristics of the specific oven that the consumer will use (*i.e.*, output wattage, cavity volume, and turntable movement). This requires that the consumer must also make an interpretation (conversion) of the manufacturer's general instructions into very exact inputs that a data entry mechanism requires in order to operate the oven in a manner that is effective and safe for the preparation of the food. Most often, the consumer chooses to make a compromise or average of values suggested in the manufacturer's instructions for the data input and accepts the resulting food quality. In other cases, the consumer re-heats the food in a second heating protocol that is experience-based, such as allowing the product to cool sufficiently for consumption. Either case is unsatisfactory as overheated food presents a physical danger and under heated food presents a microbiological danger. This complicated, inconvenient and potentially dangerous process results from a major communication deficiency between the manufacturer, the consumer and the oven, contributes to the sub-par quality of prepared foods, results in poor product value to the consumer for the food and the oven, presents potential safety problems for many consumers (especially the elderly and the young), undermines the efficiency of the product delivery system for foods and

constrains the growth of markets for prepared foods and ovens.

A data entry system described in U.S. Patent 4,323,773 provides for a microwave oven with a handheld optical scanning wand to read the bar code on the package, or the bar code associated with a recipe, which automatically enters the cooking instructions into the microprocessor for controlling the microwave power. However, this system has no capacity for automatic updating of the product and product-related cooking instruction database in the microprocessor for any new products that become available to the consumer after the cooking device has been manufactured or purchased. Further, this system uses microwave as the sole power source, which in many cases results in cooked foods of mediocre quality, compared to the superior cooked foods that can be achieved using a multi-modal cooking appliance. Moreover, the traditional bar code used by this system can store only a very small amount of data, and this limitation often excludes the option of including useful information such as those relating to nutrition and allergens in the bar code. These limitations result in a built-in and rapid obsolescence of the system, and restricts the commercial acceptance by the food manufacturer, the appliance manufacturer and the consumer.

Microwave ovens and conventional ovens, disclosed in U.S. Patent 4,816,635 and U.S. Patent 4,837,414, employ a portable, remote controller with a bar code reader to gather, store, and transmit (wireless) multiple sets of cooking programs to the oven. In each of these patents, the cooking programs are contained in the bar code or the controller, and the remote controller is used to help with menu planning or to give the user the ability to access or monitor the oven operation from a remote location for convenience. Again, these ovens have no capacity for automatic updating of the product and product-related cooking instruction database, and

the bar code method places limitations on the amount of information available.

Cooking devices disclosed in U.S. Patent 5,426,280 incorporate a sensor that is responsive to an indicia, inclusive of a bar code on a food package (such as a UPC code), that is associated with a food that is to be heated or cooked. The controller can then access a stored cooking program that has one or more steps, and then operate the cooking chamber according to the cooking program instructions. However, this cooking device also has no capacity for automatic updating of the product and product-related cooking instruction database, and the bar code method places limitations on the amount of information available.

U.S. Patent 5,812,393 discloses an interpretive BIOS machine for controlling a physical or chemical process (inclusive of the microwave heating of a food). This BIOS machine requires the creation of a separate symbol or code, manually transmitted to the process device, which can be interpreted by the BIOS for delivering the processing instructions. This machine requires the user to manually enter a predetermined code. This machine also has no capacity for automatic updating.

The present invention relates to an intelligent multi-modal food preparation appliance (hereafter called the intelligent appliance), and in particular to an improved microwave/convective/radiative heating system, that incorporates information gathering, sharing and processing capabilities allowing it to make decisions automatically that are optimal for its designed operation and for the preparation of food. The intelligent appliance simplifies the consumer preparation of the food to only three steps: transferring information from a food package to a microprocessor, inserting the food into the oven, and initiating the oven operation. Using the present invention food can be cooked via microwave energy, radiant heat and/or convective heat based on the

optimum cooking instructions to produce superior food quality. In addition, the present invention has the capacity for automatic accessing and/or updating critical information via the internet that may not be available in the database. The present invention also has the capacity for voluntary access to food related information via the internet that is not available in the database.

Summary of the Invention

An object of the present invention is to provide an intelligent multi-modal food preparation appliance which comprises: a heating system equipped with multiple heating devices and a fan; a microprocessor linked to the heating system which controls the independent operations of the multiple heating devices and fan, said microprocessor having the ability to access internal and external databases with information for operation of each; a means for transferring information provided on or with a food package to the microprocessor to initiate the microprocessor to access internal and external databases for information to operate the heating devices and/or fan of the heating system; and an internal database storage linked to said microprocessor for storage of information. Examples of heating devices useful in the present invention include, but are not limited to, magnetrons, resistive elements, quartz lamps, and halogen lamps. With a heating system equipped with such multiple heating devices, the intelligent appliance of the present invention can deliver microwave energy, radiant heat and/or convective heat based on the optimal cooking instructions encoded on a packaged food.

In a preferred embodiment, the multi-modal food preparation appliance further comprises a feedback control system with temperature and moisture sensors also connected to the microprocessor which provides feedback to the microprocessor regarding food moisture and temperature so that

operation of the heating system may be modified to produce superior quality food.

Brief Description of the Drawings

Figure 1 provides a diagram of an embodiment of the intelligent food preparation appliance of the present invention with the ability to access the internet for information regarding operation of the oven.

Figure 2 provides a diagram showing more details of a preferred embodiment of the intelligent appliance.

Figure 3 shows an algorithm for obtaining the cooking instructions for a specific packaged food.

Figure 4 shows an algorithm for generating the cooking instructions for a specific packaged food when the exact cooking instructions are not available from an internal or external database.

Figure 5 shows an algorithm for modifying the cooking instructions to accommodate the personal preferences of the user.

Detailed Description of the Invention

The present invention relates to a highly automated and efficient information gathering, sharing and processing intelligent multi-modal food preparation appliance comprising a heating system equipped with multiple heating devices and one or more fans, a means for transferring information provided on or with a food package to a microprocessor, and a microprocessor containing the control logic to access internal databases and/or external databases such as the internet information source for control of the operation of the heating devices and fan of the heating system independently to prepare food according to an operating protocol specific to the food manufacturer's instructions. Examples of heating devices useful in the heating system of this appliance include, but are not limited to, magnetrons,

one or more resistive elements, one or more quartz lamps, and one or more halogen lamps. By using multiple heating devices such as these, this appliance can prepare food via a combination of microwave, convective and/or radiant heat. In a preferred embodiment, cooking instructions are provided by means of a code or symbol on the food package which is decoded by a scanner and shared with the microprocessor of the intelligent appliance. The code or symbol operates, in part, as a key data search engine to access food preparation instructions in an internal database and/or to access an external database, preferably via the internet, to download information that is used to operate the heating system for optimal food quality and if desired, to also update the internal databases. This process is referred to as a feed forward control system. Alternate means for transferring information from the food package to the microprocessor can also be used in this system and include, but are not limited to, a magnetic stripe card, a memory button, a radio frequency signal, a readable image, and other wired or wireless electronic devices and/or readers. In a preferred embodiment, the intelligent appliance includes a separate, manually operated, internet access function that allows the operator to choose to access additional information related to the food. The intelligent appliance functions, and in particular the function of the heating devices and fan are controlled by transferring information from the food package to the microprocessor, preferably via scanning the code or symbol on the food package (e.g., a UPC bar code or a portable data file (PDF) symbol), inserting the food into the intelligent appliance, and initiating the automatic operation of the intelligent appliance. The intelligent appliance then operates automatically according to the food-specific instructions of the food manufacturer, adjusting the operating characteristics of the heating devices and/or fan of the user's intelligent appliance to match exactly the food

preparation instructions of the manufacturer for optimal food preparation. Accordingly, this intelligent appliance can deliver microwave energy, radiant heat and/or convective heat based on the optimum cooking instructions, and thereby producing a superior quality food. Additional operations which can be adjusted include such functions as the power level, the duty cycle and the turntable.

In a preferred embodiment the multi-modal food preparation appliance further comprises a feedback control system with temperature and moisture sensors also connected to the microprocessor which provides feedback to the microprocessor regarding moisture and temperature of the food and/or oven during operation. Based upon this feedback and any food manufacturer's instructions or personal preferences of the user relating to moisture and temperature, operation of the heating system of the appliance is then modified by the microprocessor to produce superior quality food.

Figure 1 shows the relationship of various components which make up the intelligent food preparation system **1**. As depicted herein, a food package **2** has a means for transferring information, typically either a bar code or a PDF symbol, for identifying the specific food product and its manufacturer, and/or for storing cooking instructions and information such as those relating to nutrition and allergens. PDF stands for portable data file. The PDF417 is a two-dimensional symbol that can carry much more information than the bar code; for example, a PDF symbol of the size of a business card can carry about 1.1 kilobytes of data for text, numbers, and graphics. The code may also contain, in addition to the bar code or PDF symbol, a time-temperature indicator (such as that using color changes to indicate temperature history) that can be read by the scanner; the indicator can provide information of the time-temperature history of the package that is useful for determining the shelf life of the product and, if necessary, make any adjustments to the cooking instructions.

Information from the code or symbol is shared with the intelligent appliance by scanning the code or symbol via a scanner **7**. As depicted in Figure 2, the scanner **7** may be incorporated directly into the heating system **1**. However, as will be obvious to those of skill in the art, the scanner **7** may also be a separate device linked to the heating system **1** and microprocessor **8**. Other means for transferring information to the microprocessor which can also be used in the present invention include, but are not limited to, a magnetic stripe card, a memory button, a radio frequency signal, a readable image, and other wired or wireless electronic devices and/or readers. The intelligent appliance is connected to the relevant sites (such as food manufacturers, food research centers, and food distribution centers) via a linkage **3** to an external database, preferably the internet, for accessing and/or updating information relating to cooking instructions, nutrition, product recalls, home shopping, etc. The intelligent appliance **1** may also be connected to an electronic display such as a touch screen **4**, as well as to a central control **5** to which other smart appliances **6** (such as computer, telephone, air conditioner, washer, and home security system) are connected. The communication connections are either cable or wireless.

In Figure 2 the intelligent multi-modal food preparation appliance is depicted in more detail. In this preferred embodiment, the intelligent appliance comprises a scanner **7** for reading the information from a code such as a UPC bar code or PDF symbol on a food package, a microprocessor **8** for processing information, and an internal database storage **9** linked to the microprocessor for storage of information, a heating system **15** and a control feedback system **14**. As shown in Figure 2, the heating system 15 and the control feedback system **14** are located with the oven portion of the intelligent appliance. The microprocessor 8 and data storage 9 can also

be incorporated within the oven portion of the intelligent appliance **1** or may be separate components linked thereto. The intelligent appliance may further comprise a means for entry of cooking instructions and other information by the user such as a keypad panel **11**. In a preferred embodiment, the keypad panel **11** contains a special button for optional access to an external database, preferably via the internet. The intelligent appliance may also have an electronic display **10** for displaying information. Alternatively, or in addition, the intelligent appliance may contain a means for entry of cooking instructions and other information such as a microphone **12** and a speaker **13** that allows the user to interact with the microprocessor **8** through voice communication technology rather than the keypad panel **11**.

The intelligent appliance of the present invention differs from prior art devices in that the code, symbol or other means used to transfer information from the food package to the microprocessor acts only as an identifier, or electronic hyperlink, to initiate an automatic search by the microprocessor for accessing the correct cooking instructions in the internal database or by accessing the necessary instructions from an external database such as the internet. In the simplest form of the present invention, the widely used and commercially proven UPC (Universal Product Code) bar code currently on all retail food packages can be utilized without change. This allows the present invention to capitalize on a commercially proven, widely utilized, highly reliable, and consumer familiar system of information exchange. However, the present invention places no restrictions on the code, on the code reader, or on the complexity of the manufacturer's heating instructions. Accordingly, PDF symbols can also be used. In addition, magnetic stripe cards, memory buttons, radio frequency signals, readable images and other wired or wireless readers and/or devices can be used.

Further, the present invention automatically updates internal databases by accessing the new product information via the internet, using the electronic linkage made at the initial scanning of the code or symbol or other means. The present invention also allows the optional accessing of related food information from an external database, preferably the internet. More specifically, the consumer has the optional benefit of accessing the external database, preferably the internet for any available information that is linked to the originally scanned identifiers (manufacturer or food product) or available through search engines at that site, such as information related to health, nutrition, allergenic ingredients, product safety issues, product recall notices, product discount coupons, product retail locations, new product introductions, etc. This can also provide a direct, real-time, communication for the manufacturer that can serve for accessing other information, such as marketing research, demographics, geographic, etc. In addition, the present invention matches the appliance-specific cooking instructions of the manufacturer to the specific appliance being used by the consumer.

To use the intelligent appliance of the present invention, the food manufacturer simply develops the cooking instructions in the traditional fashion. However, the food manufacturer has much greater flexibility in the complexity and the specificity of the instructions, since the consumer is not required to read, understand or convert the instructions, or to manually input these detailed instructions into the appliance. Hence, the manufacturer can develop cooking instructions that better optimize the prepared-food quality.

The user then simply transfers information from the food package, preferably via scanning the code or symbol on the food package, to the microprocessor with the precise and

minimal information needed to identify the food manufacturer and the specific food product to be prepared.

The microprocessor uses the identifying information from the food package to search the internal or external database for the food-preparation instructions that are specific to that product.

Figure 3 shows an algorithm which can be used for obtaining the cooking instructions for a specific packaged food. In 3.1, the code or symbol on the package **2** is scanned to identify the food and its manufacturer. In 3.2, the microprocessor **8** determines whether the cooking instructions are available in the multi-modal food preparation appliance database **9**. If yes, the microprocessor **8** accesses the cooking instructions and then proceeds to 3.6. If not, 3.3 shows that the microprocessor searches the internet via linkage **3** to find the cooking instructions. If the cooking instructions are available, 3.4 shows that the microprocessor **8** updates the internal database storage **9** with the new cooking instructions from the internet and then proceeds to 3.6. If the cooking instructions are not available, 3.5 shows that the microprocessor **8** uses the algorithm in Figure 4 to generate the cooking instructions and then proceeds to 3.6. In 3.6, the multi-modal food preparation appliance provides the user the option of customizing the cooking instructions according to personal taste by any number of means including, but not limited to, keyboard entry or voice recognition. If the user chooses this option, the microprocessor **8** modifies the cooking instructions using the algorithm in Figure 5 and then proceeds to 3.8. If the user does not choose this option, the microprocessor **8** proceeds directly to 3.8. In 3.8, the microprocessor **8** executes the cooking instructions. In 3.9, the feedback system provides input to the microprocessor **8**. In 3.10, the microprocessor **8** modifies the control of the heating devices and fan, if necessary.

The microprocessor **8**, following the internal, external or modified cooking instructions, then initiates the corresponding control of the heating system **1** of the intelligent appliance, and in particular the function of heating devices such as the magnetrons, resistive elements and lamps and/or the fan, to prepare the food using microwave energy, radiant heat and/or convective heat in exact accordance with the manufacturer's suggested food preparation instructions and the user's selections.

Figure 4 shows an algorithm for generating the cooking instructions for a specific packaged food when the exact cooking instructions are not available from the internal database **9** or via the linkage **3** to the external database. This algorithm is used in 3.5 of Figure 3. In 4.1, the microprocessor **8** identifies the food package and its manufacturer. In 4.2, the microprocessor **8** identifies the heating system **1** and its characteristics. In 4.3, the microprocessor **8** searches the internal database and the external database for similar food products. In 4.4, the microprocessor **8** uses a mathematical model to generate the cooking instructions. The mathematical models consist of semi-empirical equations and fuzzy logic sets taking into account the interactions among the food variables (size, shape, thermal properties, and dielectric properties, etc.), oven variables (cavity size, power level, etc.), package variables (size, shape, headspace volume, use of shielding devices or microwave susceptors, etc.). The semi-empirical equations and fuzzy logic sets are based on the knowledge base of food science and technology, and they use the specific information obtained in 4.1, 4.2, and 4.3 to generate the cooking instructions.

Figure 5 provides an algorithm for modifying the cooking instructions to accommodate the personal preferences of the user. This algorithm is used in 3.7 of Figure 3. In

5.1, the microprocessor **8** obtains the original cooking instructions from either 3.4 or 3.5 in Figure 3. In 5.2, the user enters his or her preferences through a means such as a keyboard panel **11** or microphone **12**. In 5.3, the microprocessor **8** uses a mathematical model to modify the cooking instructions. The model consists of semi-empirical equations and fuzzy logic sets similar to those described above, except the user preferences are also considered in modifying the cooking instructions and there is a sub-algorithm for accumulating user profile information each time a particular user operates the multi-modal food preparation appliance. In 5.4, the user preferences are stored or updated in the internal database storage **9**.

While the present invention has been described in connection with certain preferred embodiments, it is not intended to limit the scope of the invention to the particular forms set forth, but, on the contrary, it is intended to cover such alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

What is Claimed is:

1. An intelligent multi-modal food preparation appliance comprising:

(a) a heating system with multiple heating devices and a fan;

(b) a microprocessor linked to the heating system which controls independently operation of the multiple heating devices and fan of the heating system, said microprocessor having the ability to access internal and external databases with information for operation of the multiple heating devices and fan of the heating system;

(c) a means linked to the microprocessor for transferring information from a food package to the microprocessor which initiates the microprocessor to access internal and external databases for information to operate the heating system; and

(d) an internal database storage linked to the microprocessor for storage of information.

2. The multi-modal food preparation appliance of claim 1 further comprising a feedback control system connected to the heating system and microprocessor, said feedback control system comprising temperature and moisture sensors which provide feedback to the microprocessor regarding food moisture and temperature so that operation of the heating system may be modified to produce superior quality food.

3. The multi-modal food preparation of appliance of claim 1 further comprising a means for entry of cooking preferences by a user.

4. The multi-modal food preparation appliance of claim 1 wherein the multiple heating devices are selected from a group consisting of magnetrons, resistive elements, quartz lamps and halogen lamps.

5. The multi-modal food preparation appliance of claim 1 wherein said means for transferring information from a food package to the microprocessor comprises a scanner.

6. The multi-modal food preparation appliance of claim 1 wherein said means transfers information from a magnetic stripe card, a memory button, a radio frequency signal, a readable image, or another wired and wireless electronic device or reader to the microprocessor .

7. The multi-modal food preparation of appliance of claim 1 wherein the microprocessor also accesses information regarding health, nutrition, allergenic ingredients, product safety issues, product recall notices, product discount coupons, product retail locations, or new product introductions relating to food in a food package.

8. A method of preparing packaged food in a multi-modal food preparation appliance comprising:

(a) scanning a code or symbol on a packaged food via the scanner of the multi-modal food preparation appliance of claim 1;

(b) inserting the food into the heating system of said multi-modal food preparation appliance; and

(c) initiating operation of said multi-modal food preparation appliance.

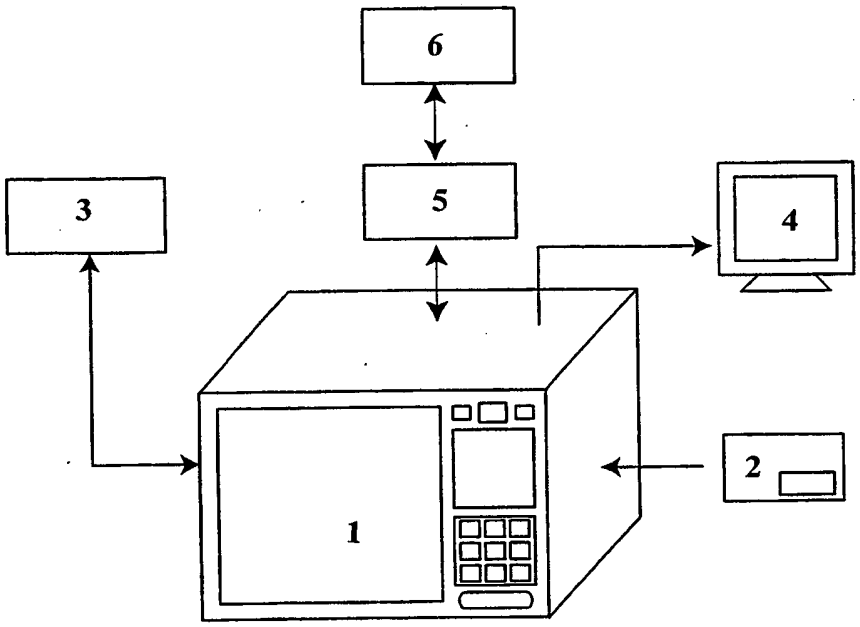

Fig. 1

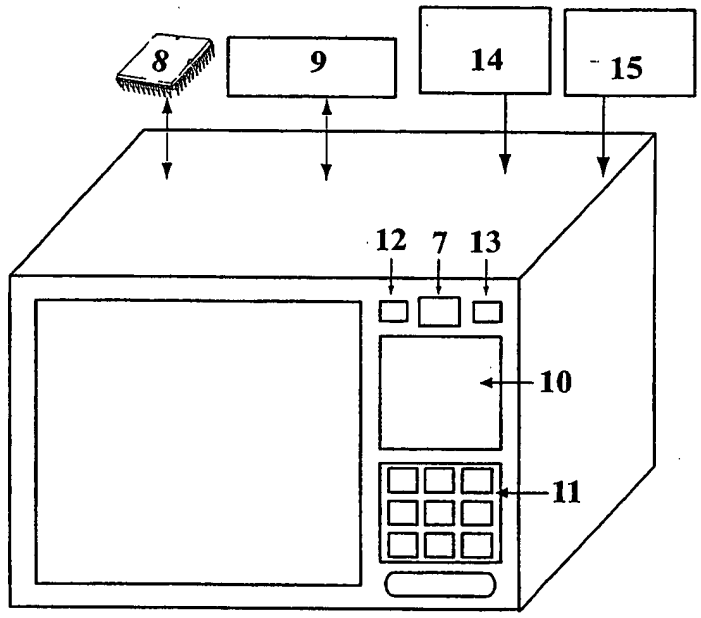

Fig. 2

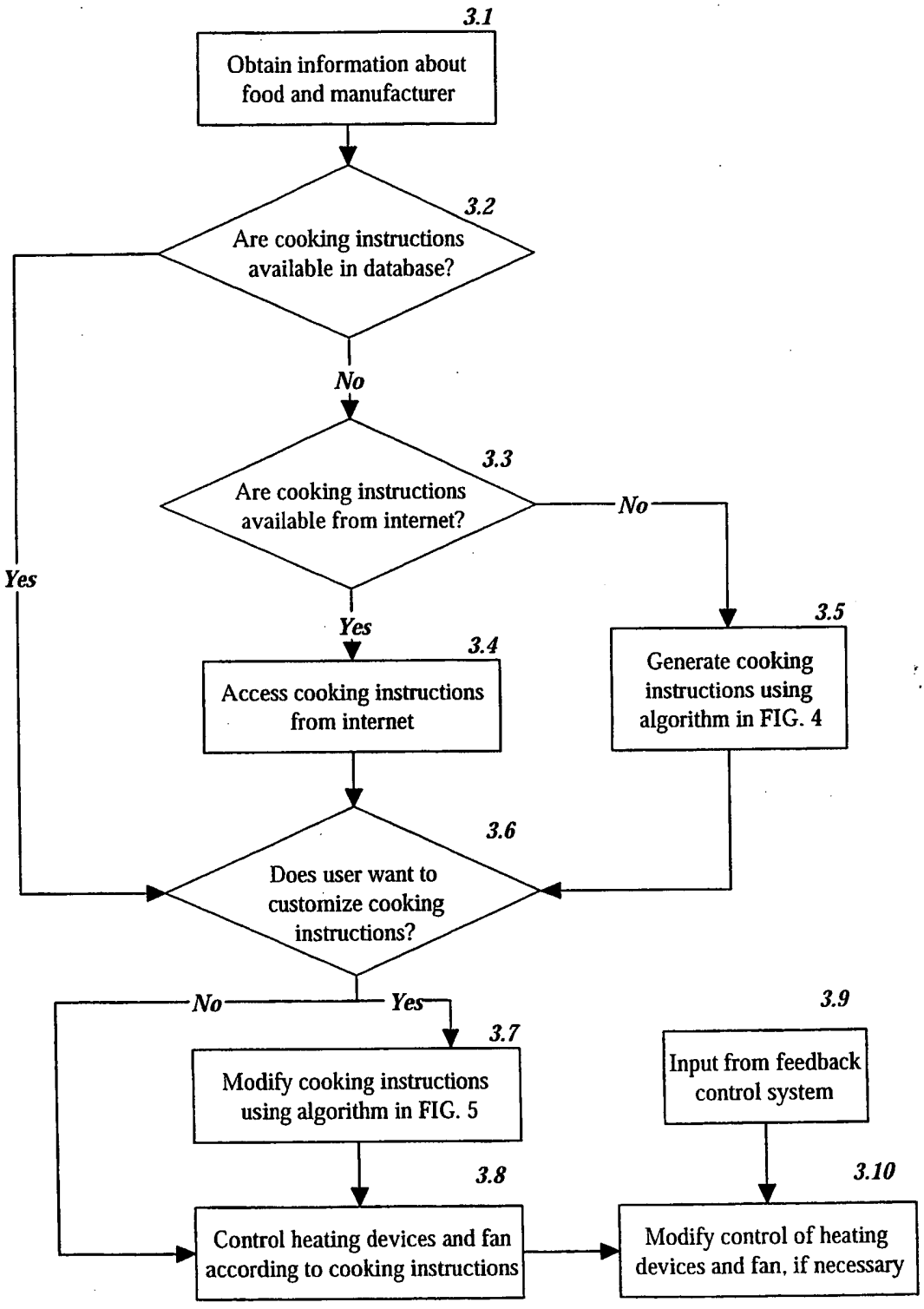

Fig. 3

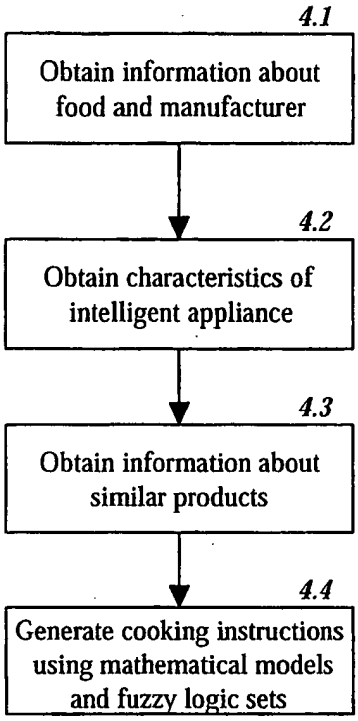

Fig. 4

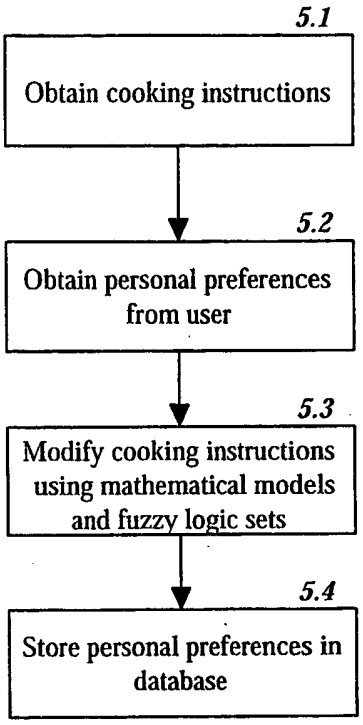

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/03884

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H05B 1/02
US CL :99/325, 331; 219/482, 704, 707; 426/523
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 99/325-333, 468; 219/703-707, 482, 492; 426/523, 520

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,484,065 A (UEDA) 20 November 1984, entire document.	1-8
A	US 4,914,277 A (GUERIN ET AL) 03 April 1990, entire document.	1-8
A	US 5,681,496 A (BROWNLOW ET AL) 28 October 1997, entire document.	1-8

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer TIMOTHY SIMONE Telephone No. (703) 308-0651

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